



Power supply systems

**Operating Instructions
"UniVert 2" inverter
and SBS option**

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Notes on these Operating Instructions

Duty to Provide Information

These operating instructions must be read carefully by all persons working with or on the inverter system prior to installation and initial start-up.

These operating instructions are a composite part of the inverter system.

The operator of this unit is obliged to make these operating instructions available to all personnel transporting or starting up units, or performing maintenance or any other work on the unit.

Validity

These operating instructions comply with the current technical specifications of the inverter system at the time of publication. The contents do not constitute a subject matter of the contract, but serve for information purposes only.

AEG reserves the right to make modifications with regard to contents and technical data in these operating instructions without prior notification. AEG cannot be held liable for any inaccuracies or inapplicable information in these operating instructions, as no obligation to continuously update the data and maintain their validity has been entered into.

Warranty

Our goods and services are subject to the general conditions of supply for products of the electrical industry, and our general sales conditions. We reserve the right to alter any specifications given in these operating instructions, especially with regard to technical data, operation, dimensions and weights. Claims in connection with supplied goods must be submitted within one week of receipt, along with the packing slip. Subsequent claims cannot be considered.

AEG will rescind all obligations such as warranty agreements, service contracts, etc. entered into by AEG or its representatives without prior notice in the event of maintenance and repair work being carried out with anything other than original AEG parts or spare parts purchased by AEG.

Handling

These operating instructions are structured so that all work necessary for start-up, maintenance and repair of the units can be performed by qualified personnel.

Illustrations are provided to clarify and facilitate certain steps.

If danger to personnel and equipment cannot be ruled out in the event of certain work, it is highlighted accordingly by pictograms explained in chapter 1, Safety Instructions.

Abbreviations

The following abbreviations are used in these instructions:

INV = Inverter

SBS = Static Bypass Switch

DOU = Display and Operation Unit

SMPS = Switch Mode Power Supply

PSM = Power Supply Monitoring

Hotline

Do you have any suggestions for improving these operating instructions?

Do you have any questions on any of the subjects dealt with in these operating instructions?

Our service department is available on the hotline number given below:



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1 Safety Instructions!

1.1 Important Instructions and Explanations

The instructions for operation and maintenance, as well as the following safety regulations must be complied with to ensure the safety of personnel as well as the availability of the unit. All personnel installing/dismantling, starting up, operating or servicing the unit must be familiar with and observe these safety regulations. Only qualified personnel may perform the described work using tools, equipment, test equipment and materials intended for the purpose and in perfect working condition.

Important instructions are highlighted by "**CAUTION:**", "**ATTENTION:**", "**NOTE:**" and indented text.



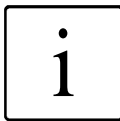
CAUTION:

This symbol identifies all working and operational procedures requiring absolute compliance to avoid any danger to personnel.



ATTENTION:

This symbol identifies all working and operational procedures requiring absolute compliance to prevent any damage, irreparable or otherwise, to the INV or its components.



NOTE:

This symbol identifies technical requirements and additional information requiring the operator's attention.

1.2 Accident Prevention Regulations

Compliance with the accident prevention regulations valid in the respective country of use and the general safety regulations in accordance with IEC 364 is mandatory.

The following safety regulations must be observed prior to any work on the inverter system:

- disconnect the power supply,
- secure against reactivation,
- verify that the unit is disconnected from the power supply,
- earth and short-circuit the unit,
- cover or isolate any neighbouring live parts.

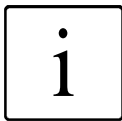
1.3 Danger during Maintenance and Repair Work

**CAUTION:**

The voltages applied to the INV can be fatal. Prior to start-up and/or maintenance work always **disconnect** the INV **from the power supply** and ensure that the unit **cannot be switched on**. The capacitors must be discharged. Free-standing and movable components can protrude into the work area and cause injuries.

**ATTENTION:**

Considerable damage can be caused to equipment if **unsuitable replacement parts** are used during repair work, if work is carried out by unauthorised personnel, or the safety regulations are not observed.

**NOTE:**

Only trained and qualified personnel may work on or in the vicinity of the INV (refer to chapter 1.4) while **strictly observing** the **safety regulations**.

1.4 Qualified Personnel

The inverter system may only be transported, installed, connected, started up, serviced and operated by qualified personnel who are familiar with the pertinent safety and installation regulations. All work performed must be inspected by responsible experts.

The qualified personnel must be authorised by the responsible safety officer of the installation to perform the work required.

Qualified personnel is defined as personnel

- having completed training and gained experience in the respective field,
- familiar with the pertinent standards, rules and regulations and accident prevention regulations,
- having received instruction on the mode of operation and operating conditions of the inverter system,
- capable of recognising and preventing dangers.

Regulations and definitions for qualified personnel can be found in DIN 57105/VDE 0105, Part 1.

1.5 Safety Awareness

The qualified personnel defined in chapter 1.4 are responsible for safety. They are also responsible for ensuring that only suitably qualified persons are permitted access to the INV system or the safety area.

The following points must be observed:

All working procedures are prohibited which are detrimental to the safety of persons and the function of the INV system **in any way**.

The INV system may only be operated in perfect working condition.

Never remove or render inoperable any safety devices.

All necessary operational measures must be initiated prior to deactivating any safety device for performing maintenance, repair or any other work on the unit.

Safety awareness also entails informing colleagues of any unsuitable behaviour and reporting any faults detected to the respective authority or person.

1.6 Application

The INV system has been designed for installation in a power supply cabinet and may only be used for uninterrupted power supply in the described installation position and operating mode while observing the maximum permissible connection values as given in these operating instructions. The unit may only be used for this intended purpose. It is not permitted to make any unauthorised modifications to the INV or to use any spare parts and replacement parts not approved by AEG SVS or to use the INV system for any other purpose.

The person responsible for the installation must ensure that:

- the safety regulations and operating instructions are readily available and are complied with,
- the operating conditions and technical data are observed,
- safety devices are used,
- the prescribed maintenance work is performed,
- the maintenance personnel is informed without delay or that the INV system is shut down immediately in the event of abnormal voltages or noise, high temperatures, vibrations or any similar effects, in order to detect the cause.

These operating instructions contain all information required by qualified personnel for operation of the INV system. Additional information and explanations for unqualified persons and for the use of the INV system in non-industrial applications is not included in these operating instructions.

The warranty obligations of the manufacturer are only applicable if these operating instructions are observed and complied with.

1.7 Liability

No liability is accepted if the inverter system is used for applications not intended by the manufacturer. Any measures necessary for the prevention of injury, or damage to equipment is the responsibility of the operator or user. In the event of any claims in connection with the unit, please contact us quoting:

- type designation,
- works number,
- reason for claim,
- period of use,
- ambient conditions,
- operating mode.

1.8 Directives

The units comply with current DIN and VDE regulations. VBG4 is met on the basis of compliance with VDE 0106 Part 100.

The requirements of VDE 0100 Part 410, "Functional extra-low voltage with safe isolation", are complied with when applicable.

The CE sign on the unit confirms compliance with the EC outline directives for 73/23 EEC – Low voltage and for 89/336 EEC – Electromagnetic compatibility if the installation and start-up instructions described in the operating instructions are observed!

2 General Information

2.1 System Description

Depending on the system design, the following versions of safe AC power supply are possible (Figure 1):

- Individual INV operation
- Parallel operation of several INVs
- Individual or parallel operation with SBS

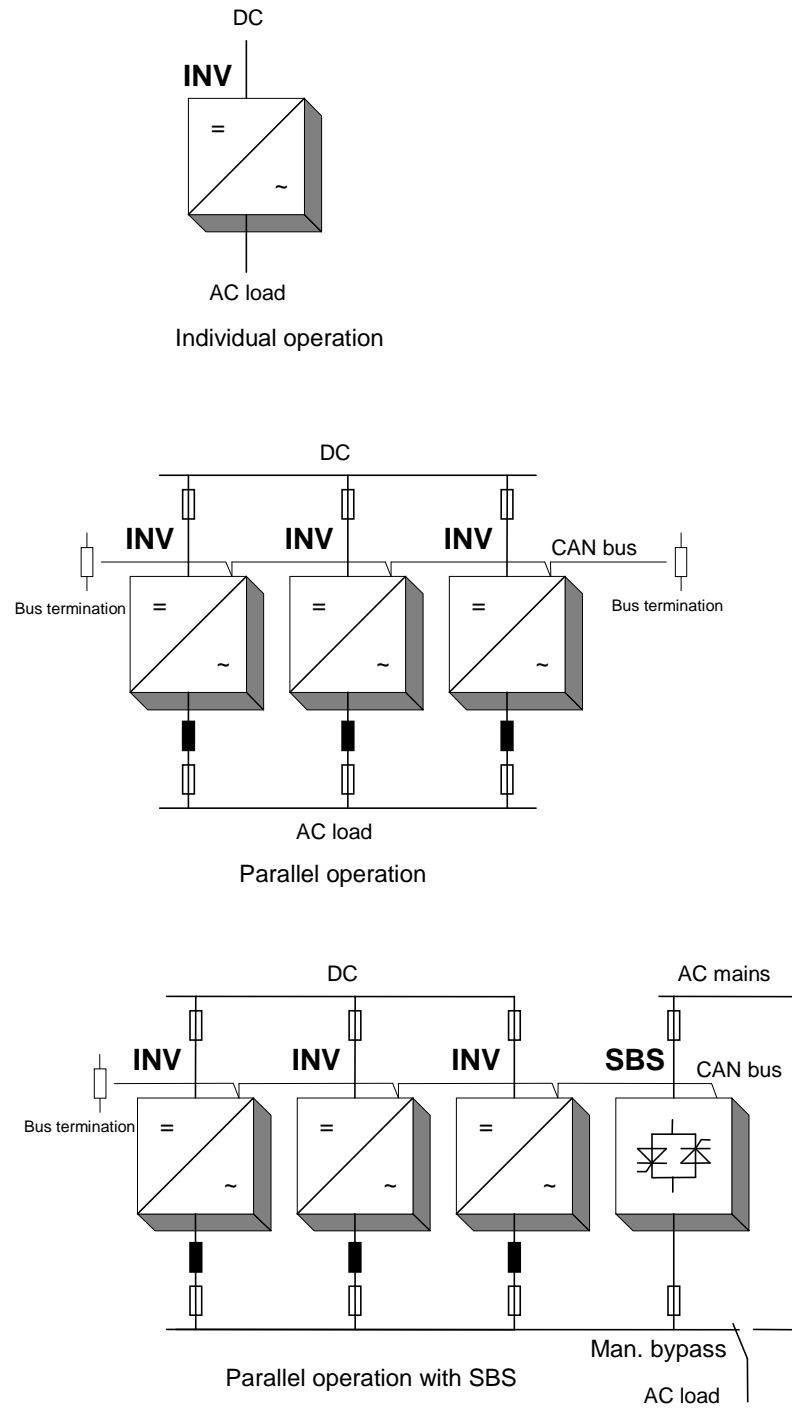


Figure 1 Block diagrams of various systems

Individual INV operation:

Here an INV is supplied with DC and itself supplies the AC load. In the event of INV fault or switch-off, the load is no longer supplied.

Parallel INV operation:

In order to increase redundancy or performance, up to 8 INVs of the same type and the same output can be connected in parallel. Note that if one or several of the INVs fail, the remaining INVs take over the load. Overload of the remaining INVs can be prevented by choosing the right number of redundant INVs. If the number of INVs that fail or are switched off exceeds the number of available redundant INVs, the remaining INVs switch off together.

When the INVs are switched back on by connecting the DC, they do not switch on their output contactors at the same time until a sufficient number of INVs (in accordance with the redundancy setting) are available to take over the load.

INVs for parallel operation need a choke between INV output and busbar.

Individual or parallel operation with SBS:

If one or more INVs are combined with an SPS, switchover of the loads from the mains to the INV and vice versa is possible without any interruption. With parallel operation systems, the load is distributed to the remaining INVs if one or several INVs fail. The system may switch over to the mains when a voltage drop occurs on the load busbar as a result of the failure of one INV, or if the number of INVs still operating is insufficient (redundancy setting). In order to switch the load back from the mains to the INVs, n-R INVs must be in operation (where R = redundant INVs).

2.2 Function of the System

Individual INV operation:

The INV as an individual unit supplies the loads. If it is switched off or disturbed, either by internal faults of the INV or by failure of the DC supply or by a DC voltage deviation, the AC loads are no longer supplied. The INV is not synchronised with the mains or other AC voltage sources. The INV can be connected to the DC voltage using a switching device on the input (miniature circuit-breaker, contactor). An internal softstart device limits the current to values below the rated current. If the INV is switched to the DC, the control unit starts operating. The INV supplies the output voltage if the unit is additionally switched on using the ON/OFF switch. If the supplying mains fails, the battery of the power supply system is discharged (also) by the INV. When the DC undervoltage monitoring value is reached, the INV is switched off. If the battery is charged after the mains voltage has returned, the INV is automatically started when a limit value of the DC undervoltage monitoring is exceeded.

Parallel INV operation:

Prerequisite for parallel operation is that the INVs on the DC and AC side are connected in parallel, interconnected via CAN bus (16-pin, X7) and correctly addressed. The general behaviour of an individual INV is as described in the previous paragraph.

The loads are only supplied with voltage when n-R INVs are switched on. The K7 output contactors of the INVs switch on simultaneously. The load is distributed equally to all the INVs in operation. If an INV is switched off or becomes faulty, the remaining INVs supply the load. The INVs are not synchronised with the mains.

When the DC undervoltage monitoring value is reached, the INVs are switched off. If the battery is charged after the mains voltage has returned, the INVs are automatically started when a limit value of the DC undervoltage monitoring is exceeded. The K7 output contactors of the INVs are switched on when n-R INVs are in operation.

In order to be able to remove one INV from the interconnected system for maintenance or repair work, we recommend providing a DC and an AC fuse for each INV.

Individual or parallel operation with SBS:

Prerequisite for operation with SBS is that the INV and SBS are connected in parallel on the AC side, interconnected via CAN bus (X7) and correctly addressed. The general behaviour of an individual INV is as described in the two previous paragraphs.

Under normal conditions, the INVs are operating synchronously with the mains and supply the AC loads. In the event of a voltage drop on the load busbar caused by the short circuit of an AC load or the failure, switch-off or overload of the INVs, the thyristor contactor of the SBS is fired and the K7 output contactors of the INVs are switched off. The loads are supplied by the mains. When the required number of INVs is available again, the loads are switched back from the mains to the INVs without interruption. If the SBS is blocked, e.g. because of mains voltage deviations, it is not possible to switch from INV to mains or vice versa.

In order to be able to disconnect the SBS from the mains and the AC busbar for maintenance or repair work, we recommend providing an AC fuse for both sides and supply the loads via the manual bypass.

2.3 Description of the INV

Its electronic high-performance components make the INV suitable for universal applications. It has a very high degree of operational reliability, optimum efficiency and excellent communication capability with other systems thanks to integrated interfaces.

The control electronics of the INV have been designed on the basis of state-of-the-art microcontroller technology. By using parameters in the software, the main unit characteristics are determined.

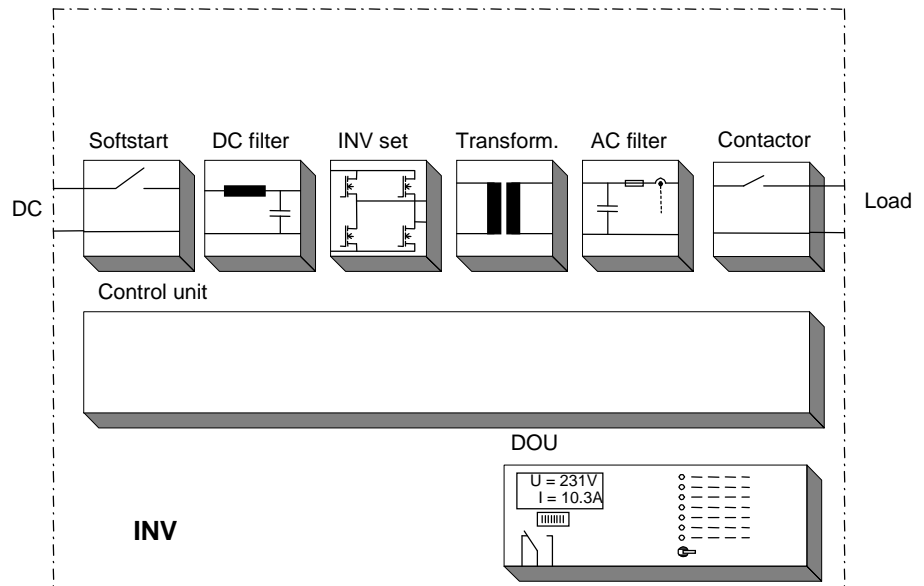


Figure 2 Block diagram of the inverter

The main assemblies of the INV are (Figure 2):

- Softstart
- DC filter
- INV set
- Transformer
- AC filter
- INV output contactor
- Control unit
- DOU

Figure 2 illustrates the principle of an INV.

In normal operation, the load is supplied "Online" by the INV. With systems comprising several parallel INVs, the load current is divided in accordance with the number of INVs. Depending on the system design, a power supply using up to 8 INVs can be realised. In addition to the parallel operation of several INVs, the reliability of supply can be further increased by integrating a static bypass switch, SBS. In the event of a failure of several INVs, switchover to the mains takes place without any interruption. Apart from power cabling, a bus line is required for control purposes between the units for systems comprising several INVs (and SBSs). The bus line has to be terminated at both ends with a resistor.

**ATTENTION:**

This INV must not be connected in parallel to the mains on the output side!

2.4 Principle of Operation of the INV, Electrical

After connection of the DC voltage, the DC filter capacitors are charged via the softstart device. The control unit activates a bridging contactor as soon as the capacitor charging process is finished. The DOU displays measured values (output voltage/output current) on the LCD and the unit status via LEDs. The INV is switched on using the ON/OFF switch on the DOU. When the INV has been switched on, it can be started or stopped by connecting or disconnecting the DC voltage supply.

The transistor INV set, pulsed with approx. 20 kHz, transforms the direct voltage into a single-phase sinusoidal AC voltage. The voltage is transformed electrically isolated to the required AC output voltage using a transformer. The secondary voltage is led to the load terminals via the AC filter, a miniature circuit-breaker, a current transformer and the INV output contactor. The stabilised output voltage of the INV is short-circuit-proof and can supply loads from capacitive through ohmic to inductive, as well a non-linear loads with a high crest factor. The INV also supplies high starting currents for motor loads. Refer to chapter "Technical data" for the exact specifications. The entire control and monitoring process is carried out using a microprocessor. LEDs and relays show the unit status, whilst output voltage and output current are displayed on an LCD. INVs for parallel operation need a choke between the INV output and the busbar. When several INVs are operated in parallel, or one or more INVs are operated with an SBS, a CAN bus is required between the units for control purposes. An additional CAN bus allows the unit to be integrated in a power supply system and connected to a central control and monitoring unit (PSM).

With individual units, the INV immediately starts after actuating the ON/OFF switch. With an INV with SBS and presence of the mains, the INV starts immediately, but the output contactor is only switched on after synchronisation with the mains. With systems comprising several INVs, these synchronise to the mains and then jointly switch on the output contactor. The INV can be switched off in every operating status without delay using the ON/OFF switch.

2.5 Description of the SBS

Its electronic high-performance components make the SBS highly overload-resistant and thus capable of quickly eliminating load short circuits.

The SBS can be used as the central SBS for parallel operation of up to 8 INVs.

Another outstanding characteristic of the SBS is its communication capability with other systems via integrated interfaces.

The control electronics of the SBS have been designed on the basis of state-of-the-art microcontroller technology. By using parameters in the software, the main unit characteristics are determined.

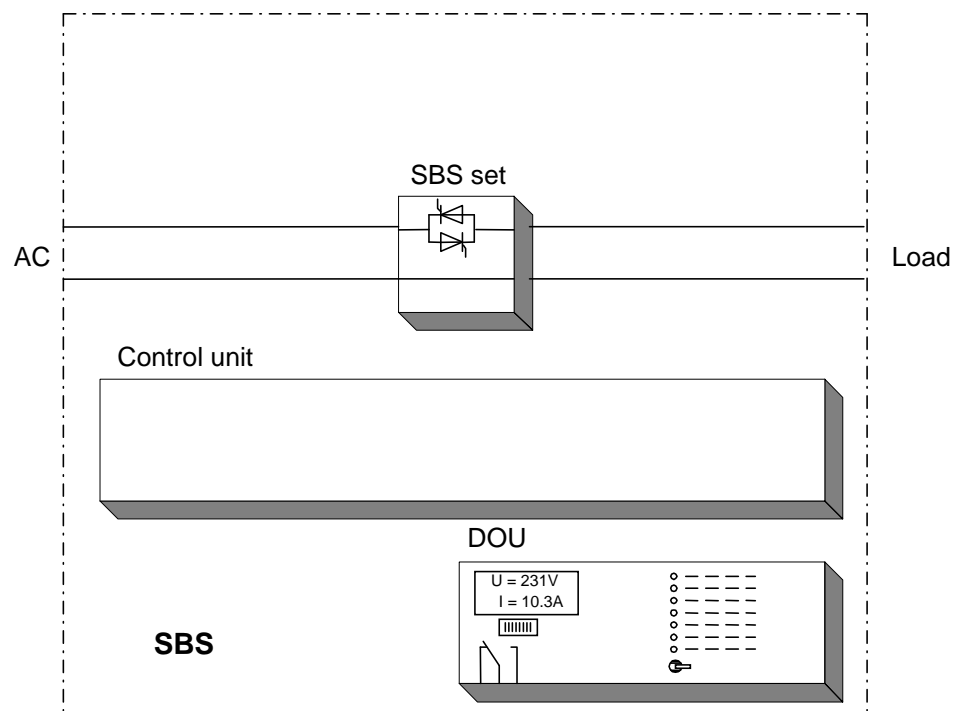


Figure 3 Block diagram of the SBS

The main components of the SBS are (Figure 3):

- Thyristor set
- Control unit
- DOU

Figure 3 illustrates the principle of an SBS.

In normal operation, the SBS is not fired, the load is supplied "Online" by the INV or INVs. If the supply of the load is no longer guaranteed by the INVs or the load voltage has dropped below a permitted value due to a load short circuit, the load is switched over to the mains without interruption.

Apart from power cabling, a bus line is required for the SBS for process control purposes between the INV/INVs and the SBS. The bus line has to be terminated at both ends with a resistor.

2.6 Principle of Operation of the SBS, Electrical

If the SBS is supplied by connecting the mains or the load voltage, the corresponding operating status is automatically activated after 3 to 5 seconds.

With mains operation, the DOU displays load voltage and SBS current. With all other operating statuses, in addition to the load voltage the corresponding status (ready, blocked, fault) is displayed.

The toggle switch on the DOU serves exclusively to acknowledge SBS faults.

The SBS control unit continually monitors the load voltage and, in the event of a load voltage deviation, initiates switchover of the loads from the INV/INVs to the SBS without interruption. Then the loads are automatically switched back to the INV/INVs. The thyristors of the SBS only quench when the supply of the loads is guaranteed by the activation of the output contactors of the INV/INVs.

When the SBS is fired, both antiparallel thyristors are triggered over the whole period ensuring reliable operation of the SBS in the entire range from inductive to capacitive load.

The entire control and monitoring process is carried out using a microprocessor. LEDs and relays show the unit status, whilst the output voltage and output current are displayed on an LCD. If the SBS is operated with one or more INVs connected in parallel, a CAN bus is required between the units for control purposes. An additional CAN bus allows the unit to be integrated in a power supply system and connected to a central control and monitoring unit (PSM).

3 Function of the Inverter

For technical data or unit settings, refer to the Technical Data Sheet in chapter 8.

3.1 DC Input

The inverter is operated with 48 V (or 60 V) DC voltage. The input voltage is fuse-protected outside the INV. For details, refer to the technical data.

An integrated softstart device limits the making current of the inverter to a value smaller than the rated input current. The input voltage is continuously monitored. (See chapter 3.3.)

3.2 AC Output

The INV output voltage is regulated to 230 V 50 H (see chapter 3.9) and monitored (see chapter 3.5). With an output voltage present and the INV in operation, the green LED lights up "U_o OK".

3.3 DC Input Monitoring System

If a value falls below the "DC undervoltage, switch-off" threshold, the INV is immediately switched off. If the input voltage rises above the acknowledgement value, the INV is switched back on. If the monitoring system is triggered, the red "U_{l<}" LED lights up.

If the "DC overvoltage, switch-off" threshold is exceeded, the red "U_{l>}" LED lights up and the INV is immediately switched off. If the value falls below the "DC overvoltage, switch-off" acknowledgement value, acknowledgement is made after a delay of 15 seconds.

3.4 Temperature Monitoring System

Overtemperature is signalled by the red "θ>" LED if the heat sink temperature exceeds critical values. The faulty unit switches off after 40 seconds. Acknowledgement is made when it has cooled down. Overtemperature can result from e.g. high ambient temperature, constant overload of the INV or from fan failure.

3.5 Output Voltage Monitoring System

The INV output voltage is regulated to 230 V 50 Hz (see chapter 3.9) and monitored. With an output voltage present and the INV in operation, the green "U_o OK" LED lights up. When the output voltage drops below 90% of the rated value, e.g. due to overload, short circuit or the triggering of a miniature circuit-breaker, the INV switches off after 2.5 seconds. The unit is not automatically switched back on.

3.6 Monitoring of Functions

After connecting the input voltage, the self-test of the microcontroller control system is carried out automatically.

3.7 ON/OFF Switch

The inverter is set ready for operation using the DOU switch on the front panel. The monitoring functions with their respective messages are only active when the inverter is switched on. After switch-off, all faults are acknowledged. The settings of the DIL switches are only accepted if the unit is switched off!

3.8 CAN Bus Interfaces X6 / X7

The unit can be controlled and monitored using the 10-pin CAN bus connector X6 if the INV is installed in a power supply cabinet with PSM control unit.

The CAN bus connector X7 has no significance if one inverter in single operation operated without SBS. Both ends of the bus have to be connected to a terminating resistor when several INVs are operated in parallel!

For operation with SBS, only the end of the bus on the INV must have a terminating resistor connected; a bus terminating resistor is integrated in the SBS! (See Figure 1.)

3.9 DIL Switch

An 8-pin DIL switch is arranged below the LCD. All settings of / changes to the DIL switch are only activated after the INV has been switched off using the ON/OFF switch. It is counted from the left S2.1 to the right S2.8, switches that are pushed in at the bottom signify "open"! The setting of the switches is shown on the display as a check whenever a change is made; 0 = open; 1 = closed.

Switches S2.1, S2.2 and S2.3: Number of parallel INVs in the system

The settings must be the same on all INVs and the SBS!
Standard setting:

1 INV: S2.1, S2.2 and S2.3 open

	S2.1	S2.2	S2.3
1 INV	0	0	0
2 INVs	0	0	1
3 INVs	0	1	0
4 INVs	0	1	1
5 INVs	1	0	0
6 INVs	1	0	1
7 INVs	1	1	0
8 INVs	1	1	1

Switches S2.4, S2.5 and S2.6: Own Address (INV)

The settings must be different on all INVs!

Standard setting:

Address 1: S2.4, S2.5 and S2.6 open

	S2.4	S2.5	S2.6
Address 1	0	0	0
Address 2	0	0	1
Address 3	0	1	0
Address 4	0	1	1
Address 5	1	0	0
Address 6	1	0	1
Address 7	1	1	0
Address 8	1	1	1

**ATTENTION:**

With parallel operation systems, the addresses set must not exceed the number of parallel INVs in the system; for example, in a system with 2 parallel inverters only address 1 or 2 may be set. Addresses 3 or 4 are then only permissible for individually operated INVs!

Switches S2.7 and S2.8: Number of redundant INVs

	S2.7	S2.8
0 INVs	0	0
1 INV	0	1
2 INVs	1	0
3 INVs	1	1

The settings must be the same on all INVs and the SBS!

Standard setting: S2.7 and S2.8 open

Example: 4 INVs are in the system, at least 3 INVs should run, i.e. 1 INV is redundant: S2.1=0; S2.2=1; S2.3=1; S2.7=0; S2.8=1

3.10 Signalling, Displays and Remote Signals

The following signals are indicated via LEDs on the front panel:

Display	Colour	Operating status
Operation	green	INV operation
U _o OK	green	INV output voltage present
U _i <	red	Input voltage < 85% of rated voltage, INV has switched off
U _i >	red	Input voltage > 128% of rated voltage, INV has switched off
Fault	red	INV output voltage below 90% of rated voltage
ϑ>	red	Overtemperature on heat sink or overload
Collective fault	red	Delayed collective fault signal, delay time 20 s, signalling relay is triggered at the same time. The following disturbing influences are registered: INV fault U _i < U _i > ϑ> Overload INV output miniature circuit-breaker

The unit is equipped with a liquid-crystal display. When the unit is switched off, the LCD shows "OFF", when the unit is switched on it shows the INV output voltage and output current. While the INV starts up and output contactor K7 is still switched off, "READY" is signalled.

In the event of a fault, the 1st display row shows "FAULT" and the 2nd display row shows the type of fault.

The INV voltage and current values are displayed with three decimals before and one decimal after the decimal point. The display accuracy corresponds to class 1 with respect to the rated output value of the unit.

Remote signalling is carried out by means of potential-free contacts via a Combicon connector on the front of the unit.

Assignment of the signal terminals:

INV fault:

In the event of a signal, X10.2 – X10.3 or X3.2 – X3.3 close.

No fault: X10.2 – X10.1 or X3.2 – X3.1.

When the INV is disconnected from the power supply (no DC supply), a fault is signalled!

The remote signals are designed for safe isolation. The minimum load should not be below 12 V and 0.1 A.

4 Function of the SBS (optional)

For the technical data or unit settings, refer to the chapter "Technical Data".

4.1 Operating Statuses

The following operating statuses are possible:

"PowerUp":

Status after PowerUp or Reset. The control system checks the ambient conditions.

"on":

Mains operation: The SBS supplies the load.

"ready":

In the event of load voltage deviation or INV failure / switch-off, the SBS takes over the load without interruption, i.e. the SBS control system switches over to the "on" operating status.

"blocked":

The SBS control unit is blocked. In the event of load voltage deviation or INV failure / switch-off, the SBS does not take over the load, i.e. the SBS control system remains in the "blocked" operating status. The operating status "blocked" is activated in the event of mains failures or phase deviations.

"Fault":

A fault has occurred in the SBS. This fault must be remedied and acknowledged using the Reset button.



ATTENTION:

If the INV is switched off in the event of a blocked or faulty SBS, the loads are no longer supplied with power.

4.2 Switchback Attempts

Should the load voltage deviate excessively e.g. due to overload of the INVs or load short circuits (see chapter 4.4), the loads are automatically switched over to the SBS without interruption. Then the loads are also automatically switched back to the INV. If this switchback attempt fails, the SBS continues to supply the loads. After 3 unsuccessful switchback attempts within 1 minute, the INV is switched off and the loads remain supplied by the SBS.

4.3 AC Mains Input (X1)

The SBS is connected to a 230 V AC mains.

The input voltage is fuse protected outside the SBS. For details refer to the technical data.

The input voltage is continuously monitored (see chapter 4.4).

When the mains voltage is present, the green "mains present" LED lights up.

4.4 AC Busbar (X2)

The AC busbar is either supplied by the INV output voltage or the SBS output voltage which corresponds to the SBS circuit voltage.

The INV output voltage is regulated to 230 V 50 H (see chapter 3.9) and monitored (see chapter 3.5).

The load is only switched over to the SBS circuit if it lies within the defined tolerances and if a load voltage deviation is detected.

4.5 AC Mains Monitoring System

When the mains voltage is no longer within the tolerance range, the "mains present" LED goes off.

The SBS changes the operating status from "ready" to "blocked".

If the SBS is fired, the operating status does not change!

The acknowledgement is carried out automatically as soon as the mains voltage is back within the tolerance range. The green "mains present" LED is lit, the SBS changes from "blocked" to "ready".

4.6 AC Busbar Monitoring System

If the load voltage leaves the tolerance range, the load is switched over to the SBS circuit without interruption. For this switchover, the SBS must be in the "ready" operating status.

4.7 Temperature Monitoring System

Overtemperature is signalled by the red "collective fault" LED if the heat sink temperature exceeds critical values. Acknowledgement is made when it has cooled down.

Overtemperature can result from e.g. high ambient temperature, constant overload of the SBS or from fan failure.

4.8 Monitoring of Functions

After connecting the input voltage, the self-test of the microcontroller control system is carried out automatically.

4.9 Reset Button

The Reset button is used to acknowledge SBS faults. The Reset button must also be pressed to accept the settings of the DIL switches.

4.10 CAN Bus Interfaces (X6, X7)

The unit can be controlled and monitored via the 10-pin CAN bus connector X6, if the SBS is installed in a power supply cabinet with PSM control unit.

The CAN bus connector X7 is always required for communication with the INV when operated with SBS. In this case, only the end of the bus on the INV must have a terminating resistor connected; a bus terminating resistor is integrated in the SBS! (See Figure 1.)

4.11 DIL Switch

An 8-pin DIL switch is located below the LCD. All settings of/ changes to the DIL switch are only activated at mains operation, i.e. when the operating status is "on". Also press the Reset button to take over the settings of the DIL switches. It is counted from the left S3.1 to the right S3.8, switches that are pushed in at the bottom signify "open"! The setting of the switches is shown on the display as a check whenever a change is made; 0 = open; 1 = closed.

Switches S3.1, S3.2 and S3.3: Number of parallel INVs in the system

The settings must be the same on all INVs and the SBS!

Example: 4 INVs are in the system, at least 3 INVs should run, i.e. 1 INV is redundant: S3.1=0; S3.2=1; S3.3=1; S3.7=0; S3.8=1

	S3.1	S3.2	S3.3
1 INV	0	0	0
2 INVs	0	0	1
3 INVs	0	1	0
4 INVs	0	1	1
5 INVs	1	0	0
6 INVs	1	0	1
7 INVs	1	1	0
8 INVs	1	1	1

Switches S3.7 and S3.8: number of redundant INVs

	S3.7	S3.8
0 INVs	0	0
1 INV	0	1
2 INVs	1	0
3 INVs	1	1

The settings must be the same on all INVs and the SBS!

Standard setting: S3.7 and S3.8 open

Switches S3.4 and S3.5: not used

Switch S3.6: Switchover with gap (yes/no)

Standard setting: switchover **not** with gap - S3.6 open

i.e. in the event of phase deviations between INV and SBS, the SBS blocks.

If switchover with gap is selected (- S3.6 closed), the SBS does not block in the event of a phase deviation (see chapter 4.12).

4.12 Signalling, Displays and Remote Signals (X4)

The following signals are indicated via LEDs on the front panel:

Display	Colour	Operating status
SBS operation	green	SBS is in operation, operating voltage present
INV present	green	INV voltage present
Mains present	green	Mains voltage present
Synchronism	green	Mains and INV run synchronously
Load on INV	green	The INV supplies the load
Load on the mains	green	The mains supplies the load
Collective fault	red	Collective fault signal delayed by 20 s, the signalling relay is triggered at the same time.

The unit is equipped with a liquid-crystal display.

The following displays are to be expected during the corresponding operating statuses.

Mains operation:

"U=230.0V" Load voltage

"I=13.7A" SBS current

With SBS ready:

"U=230.0V" Load voltage
" ready" Operating status

With SBS blocked:

"U=230.0V" Load voltage
"blocked" Operating status

With SBS Power Up:

" " (nothing displayed)
"PowerUp" Operating status

With SBS fault:

" " (nothing displayed)
" fault" Operating status

The busbar voltage and current values are displayed with three decimals before and one decimal after the decimal point. The display accuracy corresponds to class 1 with respect to the rated output value of the unit.

Remote signalling is carried out by means of potential-free contacts via a Combicon connector on the front of the unit.

Assignment of the signal terminals:

SBS fault:

In the event of a signal, X4.2 – X4.3 close, no fault: X4.2 – X4.1

- When the SBS is disconnected from the power supply (no mains / INV supply), a fault is signalled!

INV operation:

In the event of a signal, X4.4 – X4.5 close

The remote signals are designed for safe isolation. The minimum load should not be below 12 V and 0.1 A.

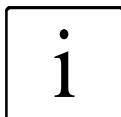
4.13 Operating modes

Two operating modes can be selected using the DIL switches (see chapter 4.11).

Switchover without gap:

The switchover from INV to SBS is always carried out without interruption. If the INV and SBS circuit are not synchronous, the SBS blocks. If the INV is switched off due to asynchronism or if it fails, the load is not supplied by the SBS.

This operating mode is set ex works and is recommended.

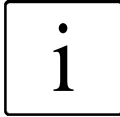


NOTE:

If the mains are poor or the SBS circuit is supplied by a diesel generator for example, the SBS can be temporarily blocked due to frequency deviations.

Switchover with gap:

The switchover from INV to SBS is carried out without interruption if the INV and SBS circuit are synchronous. If the INV and SBS circuit are not synchronous, the SBS does not block in this operating mode. If the INV is switched off due to asynchronism or if it fails, the load is supplied by the SBS after a load voltage gap of 140 ms.



NOTE:

If the operating mode "Switchover with gap" is selected, the connected loads must be able to withstand a gap of 140 ms and a phase shift that might follow.

5 Start-Up

5.1 Installation

When installing the INV, the following regulations must be observed:

- The INV has been designed for use in a dry room, practically free of dust.
- It is imperative to observe the specifications concerning ambient temperature and site altitude (see chapter "Technical Data").
- Severe dust accumulation or a chemically aggressive atmosphere are not permissible; the system must be especially protected against conductive, humid dust deposits and condensation.
- The INV functions with forced air cooling. The supply air temperature must not exceed 45°C. The power loss of an INV is below 340 W at rated load.
- The inverter must be installed in suitable module racks.

5.2 Connection

Before connecting the unit to the DC supply, ensure that the voltage values given on the nameplate correspond to the supplied voltages. The load is connected using terminals X2 (L1, N) on the front of the unit. The DC supply is connected using terminals X1 (L-, L+). The INV has to be earthed using a separate PE connection on the front of the unit. The cross-section of the PE conductor must be chosen in acc. with VDE 0100 Part 540 depending on the type of installation.

The discharge current lies below 3.5 mA. Prior to start-up, a PE conductor connection must be established.

With earthed DC systems, only the pole of the INV DC connection that is not earthed needs protection.

Observe correct polarity of the DC lines.

The load current must be checked before connecting the load; a permanent overload is not permissible and has a very negative impact on the reliability and the service life of the unit.

DIL switch (see chapter 3.9 or chapter 4.11)

CAN bus (see chapter 3.8 or chapter 4.10)

Remote signals (see chapter 3.10 or chapter 4.12)

5.3 Connecting the Loads / DC / Mains

When all lines have been connected completely, proceed as follows:

Individual INV operation:

- Switch off the INV, switch on miniature circuit-breaker F1
- Connect the DC supply (The INV has a softstart device that limits the charging current in the input capacitors to a value below the rated current of the unit.)
- Switch on the INV
- Connect the load

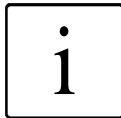
Parallel INV operation:

- Switch off the INV, switch on miniature circuit-breaker F1
- Set the DIL switches
- Insert the AC fuses
- Connect the DC supply
- Switch on all INVs one after the other
- (The output contactors K7 of the INVs start at the same time as soon as n-R INV have been switched on)
- Connect the load

Individual or parallel operation with SBS

- Switch off the INVs, switch on miniature circuit-breaker F1
- Set the DIL switches (INV and SBS)
- Engage the AC fuses (INV output)
- Engage the AC mains and output fuses of the SBS
- Disconnect the manual bypass
- Connect the load
- Connect the DC supply
- Switch on all INVs one after the other

(The K7 output contactors of the INVs start at the same time as soon as the last INV has been switched on and the INVs have synchronised to the mains.)

**NOTE:**

Before switching on the INVs in parallel operation, or the SBS, make sure the setting of the DIL switches is correct (see chapters 3.9 and 4.11)!

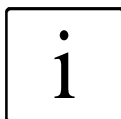
INVs in parallel operation must be set to the same output voltage, to the same number of INVs in the system and to different addresses!

5.4 Disconnection

Even when switched off, the inverter can still be live due to charged capacitors and external signals. For this reason the terminals must be tested prior to dismantling the unit to ensure that they are de-energised.

The capacitors can be discharged via an external resistor on terminals X2 or X1: L+ and L-.

- Switch off the INV
- Switch off the AC fuses, if present
Switch off the DC supply
- Disable interfaces X6, X7, X3
Disconnect earthing

**NOTE:**

Before switching off an INV in the parallel system, check whether the remaining INVs can take over the entire load. If necessary, the load current must be reduced by switching off individual loads!

6 Maintenance

Attention! Disconnect the unit from the power supply prior to all maintenance work. Always observe the safety instructions! (See chapter 1.)

The INV consists of state-of-the-art components which are almost non-wearing. We do, however, recommend regular visual and functional tests of the unit to maintain its continuous availability and operational reliability.

When visually inspecting the unit, check whether:

- there is any mechanical damage or foreign bodies are present,
- any conductive dirt or dust has accumulated in the unit, and whether
- accumulation of dust affects heat supply and dissipation.

If large quantities of dust have accumulated, the unit should as a precaution be cleaned with dry compressed air, in order to ensure adequate heat dissipation.

The intervals at which visual checks should be performed are largely determined by the site conditions. The unit must not be operated in an aggressive atmosphere.

7 Troubleshooting

Attention! All work on the unit may be carried out by specially trained qualified personnel only. Always observe the safety instructions! (See chapter 1.)

7.1 No Output Voltage or Output Current Present (with connected load)

Individual INV operation:

- DC present and correct polarity?
- Are the LCD and the fan working? (Control unit is supplied with power)
- Is the INV switched on?
- Is the miniature circuit-breaker F1 switched on?
- Has a monitoring system responded?

(Switch the INV OFF and back ON)

With INVs in parallel operation: (additionally)

- LCD shows output voltage but no current:
AC fuse faulty? Check output voltage of the unit
INV does not synchronise and does not switch on the output contactor

For systems with SBS: (additionally)

- LCD shows output voltage but no current:
INV does not synchronise and does not switch on the output contactor
Is the SBS blocked?

If all aforementioned points are OK, proceed as follows:

- Disconnect the unit and disassemble it (see chapter 5.4)
- Unscrew the cover
- Observe the safety instructions!
- Check fuse F1 on printed circuit board A3.1 (softstart)
- Check fuse F100 on printed circuit board A17 (INV interface, auxiliary power supply)
- Check fuse F1 on printed circuit board A17 (INV interface, 24 V for fan, relay, INV control)
- Check plug connections for correct position

If the fault cannot be eliminated, return the unit to the works for repair enclosing a fault description.

7.2 Output Voltage Deviation

- Did the INV cause the output voltage deviation?
- Is the unit running with current limiting due to overload?
Reduce the load!

8 Technical Data

8.1 General Data INV

DC input current	< rated input current
DC fuse required	gL 80 A with type 3.3 kVA 48 V gL 63 A with type 3.3 kVA 60 V gL 20 A with type 3.3 kVA 220 V gL 80 A with type 1.5 kVA 24 V gL 36 A with type 1.5 kVA 48 V gL 32 A with type 1.5 kVA 60 V gL 25 A with type 2.5 kVA 110 V
Manufacturing and type test	In acc. with DIN 60146 Part 1-1
Emitted interference in acc. with EN 50081-1	
- Conducted interference	In acc. with EN 55022 Class "B"
- Emission	In acc. with EN 55022 Class "B"
Noise immunity in acc. with EN 50082-2	
- Housing	ESD test to EN 61000-4-2, 6 kV contact HF field to EN 61000-4-3, 10 V/m (30 MHz – 1 GHz)
- Power cables	Burst test in acc. with EN 61000-4-4, 2 kV Surge test in acc. with EN 61000-4-5, 2 kV asymmetrical
- Control cables	Burst test in acc. with EN 61000-4-4, 2 kV Surge test in acc. with EN 61000-4-5, 2 kV asymmetrical
Functional extra-low voltage	With safe isolation at $U_O \leq 60$ V DC to VDE 0100 Part 410 11.83 Section 4.3.2
Dynamic response	$\leq 3\%$ with sudden load fluctuations between 0%-100%-0% rated output current
Overload behaviour	1.6 x rated current for 1 minute 1.3 x rated current for 10 minutes
Short-circuiting	Continued short-circuit-proof

Messages	<ul style="list-style-type: none"> - Operation LED green - Output voltage ok LED green - Input undervoltage $U_{E<}$ LED red - Input overvoltage $U_{E>}$ LED red - Fault LED red - Overtemperature $\vartheta>$ LED red - Collective fault LED red
Remote signals (X3)	<p>Operation and collective fault message via potential-free relay contact (safe isolation). Max. contact load: 150 V DC < 1.6 A Min. contact load: 12 V 0.1 A</p>
Monitoring systems.....	<ul style="list-style-type: none"> - INV output undervoltage - INV output overvoltage - DC undervoltage - DC overvoltage - Heat sink overtemperature - Overload / short circuit - Self-test, watchdog - Internal auxiliary voltages - Individual set fault, K7 fault
Design	19" mounting rail for installation in module rack in acc. with DIN 41494
Protection class	IP 20
Cooling	Forced air cooling
Intake air temperature	With $U_0 = 230$ VAC, rated current and $\cos \varphi = 0.8$ 0°C to 45°C, measured below the inverter
Storage temperature.....	-20°C to +70°C
Ambient conditions	IEC 721 Part 3-3 Class 3K3 / 3Z1 / 3B1 / 3C2 / 3S2 / 3M2
Site altitude.....	Up to 2000 m above sea level

Mechanical stability and vibration resistance	To VDE 0160 Version 5.88 Item 7.2.2
Surface painted with	RAL 7032 (front panel)
Dimensions (w x h x d)	483 x 174 x 460 mm (19" x 4 height modules) (type 1.5 and 3.3 kVA) 483 x 174 x 400 mm (19" x 4 height modules) (type 2.5 kVA)
Weight	Approx. 46.5 kg (type 3.3 kVA) Approx. 39 kg (type 2.5 kVA) Approx. 33.1 kg (type 1.5 kVA)
Noise generation	< 50 dB(A)
Connections	
X1 DC input:	Screw terminal 10 ... 25 mm ² (type 1.5 and 3.3 kVA) Screw terminal 0.5 ... 10 mm ² (type 2.5 kVA)
X2 AC output:	Screw terminal 0.5 ... 10 mm ²
X3 remote signals:	Screw terminal 0.2 ... 2.5 mm ²
PE conductor:	M4 thread
CAN bus interface X6	10-pin socket connector with insulation displacement technology in acc. with DIN 41651
CAN bus interface X7	16-pin socket connector with insulation displacement technology in acc. with DIN 41651

8.2 General Data SBS

Required AC fuse	Max. gL 125 A
Manufacturing and type test	In acc. with DIN 60146 Part 1-1
Emitted interference in acc. with EN 50081-1	
- Conducted interference	In acc. with EN 55022 Class "B"
- Emission	In acc. with EN 55022 Class "B"
Noise immunity in acc. with EN 50082-2	
- Housing	ESD test to EN 61000-4-2, 6 kV contact HF field to EN 61000-4-3, 10 V/m (30 MHz – 1 GHz)

- Power cables	Burst test in acc. with EN 61000-4-4, 2 kV Surge test in acc. with EN 61000-4-5, 2 kV asymmetrical
- Control cables	Burst test in acc. with EN 61000-4-4, 2 kV Surge test in acc. with EN 61000-4-5, 2 kV asymmetrical
Functional extra-low voltage	With safe isolation at $U_O \leq 60$ V DC to VDE 0100 Part 410 11.83 Section 4.3.2
Overload behaviour	1.6 x rated current for 1 minute 1.3 x rated current for 10 minutes The mains fuse used must be taken into consideration!
Max. load fusing	gL 40A
Messages	- Operation LED green - INV voltage present LED green - Mains volt. present LED green - Synchronism LED green - INV supplies the load LED green - SBS suppl. the load LED green - Collective fault LED red
Remote signals (X4)	Collective fault signal via potential- free relay contact X4.1,2,3 (safe isolation) INV operation signal via potential- free relay contact X4.4,5,6 (safe isolation) Max. contact load: 150 V DC < 1.6 A Min. contact load: 12 V 0.1 A
Monitoring systems.....	- Load undervoltage - Load overvoltage - Mains undervoltage - Mains overvoltage - Heat sink overtemperature - Mains / INV synchronism - Self-test, watchdog - Internal auxiliary voltages
Design	19" mounting rail for installation in module rack in acc. with DIN 41494

Protection class	IP 20
Cooling	Forced air cooling
Intake air temperature	At rated current 0°C to 45°C, measured below the SBS
Storage temperature.....	-20°C to +70°C
Ambient conditions	IEC 721 Part 3-3 Class 3K3 / 3Z1 / 3B1 / 3C2 / 3S2 / 3M3
Site altitude.....	Up to 2000 m above sea level
Mechanical stability and vibration resistance.....	In acc. with VDE 0160 Version 5.88 Item 7.2.2
Surface painted with	RAL 7032 (front panel)
Dimensions (W x H x D)	483 x 174 x 400 mm (19" x 4 height modules)
Weight	Approx. 13.5 kg
Noise generation	< 50 dB(A)
Connection system	
X1 AC mains input:.....	Screw terminal 10 ... 25 mm ²
X2 AC output:	Screw terminal 10 ... 25 mm ²
X4 remote signals:.....	Screw terminal 0.2 ... 2.5 mm ²
PE conductor:	M4 thread
X6 CAN bus interface	10-pin socket connector with insulation displacement connection system in acc. with DIN 41651
X7 CAN bus interface	16-pin socket connector with insulation displacement connection system in acc. with DIN 41651

8.3 Electrical Data

Type E-number	G48 – 60 E230/14,4/2rfg-CFp3,3 3000000352	G220 E 230/14,4/2rfg-CFp3,3 300000601
Rated output capacity	3.3 kVA	
with power factor	0.8	
Power factor range	0 inductive to 0 capacitive	
Rated output voltage	230 V ± 0.5 static, $\pm 3\%$ dynamic at 100% load connection	
Output frequency	50 Hz $\pm 0.05\%$	
THD factor	< 3%	
Rated output current	14.4 A	14.4 A
DC rated input voltage	48 V -15% / 60 V +20%	220 V -15% +20%
DC rated current	64 A at 48 V / 51 A at 60 V	14 A at 220 V
Efficiency	> 85%	> 86%
DC input current ripple	< 10% of DC rated current	
Monitoring systems		
DC undervoltage, switch-off	Fault < 85% of 48 V (40.8 V), without delay Acknowledgement > 103% of 48 V (49.4 V), 15 s delay	Fault < 85% of 220 V (187 V), without delay Acknowledgement > 103% of 220 V (226 V), 15 s delay
DC overvoltage, switch-off	Fault > 128% of 60 V (76.8 V), without delay Acknowledgement < 125% of 60 V (75 V), 15 s delay	Fault > 128% of 220 V (281 V), without delay Acknowledgement < 125% of 220 V (275 V), 15 s delay
AC undervoltage, switch-off	Fault < 90% rated (207 V), 2.5 s delay Acknowledgement by ON/OFF switch	
Overtemperature, switch-off	Fault > 80 °C, acknowledgement < 70 °C, approx. 5 s delay	

Type E-number	G48 – 60 E230/6,5/2rfg-CFp1,5 3000000351	G24 E230/6,5/2rfg-CFp1,5 3000000602
Rated output capacity	1.5 kVA	
with power factor	0.8	
Power factor range	0 inductive to 0 capacitive	
Rated output voltage	230 V ± 0.5 static, $\pm 3\%$ dynamic at 100% load change	
Output frequency	50 Hz $\pm 0.05\%$	
THD factor	< 3%	
Rated output current	6.5 A	6.5 A
DC rated input voltage	48 V -15% / 60 V +20%	24 V -15% +20%
DC rated current	29 A at 48 V / 23 A at 60 V	62 A at 24 V
Efficiency	> 85%	> 80%
DC input current ripple	< 10% of DC rated current	
Monitoring systems		
DC undervoltage, switch-off	Fault < 85% of 48 V (40.8 V), without delay Acknowledgement > 103% of 48 V (49.4 V), 15 s delay	Fault < 85% of 24 V (20.4 V), without delay Acknowledgement > 103% of 24 V (24.7 V), 15 s delay
DC overvoltage, switch-off	Fault > 128% of 60 V (76.8 V), without delay Acknowledgement < 125% of 60 V (75 V), 15 s delay	Fault > 128% of 24 V (30,7 V), without delay Acknowledgement < 125% of 24 V (30 V), 15 s delay
AC undervoltage, switch-off	Fault < 90% rated (207 V), 2.5 s delay Acknowledgement by ON/OFF switch	
Overtemperature, switch-off	Fault > 80 °C, acknowledgement < 70 °C, approx. 5 s delay	

Type E-number	G110 E230/10,9/2rfg-CFp2,5 3000000263
Rated output capacity	2.5 kVA
with power factor	0.8
Power factor range	0 inductive to 0 capacitive
Rated output voltage	230 V ± 0.5 static, $\pm 3\%$ dynamic at 100% load change
Output frequency	50 Hz $\pm 0.05\%$
THD factor	< 3%
Rated output current	10.9 A
DC rated input voltage	110 V -15% ... +20%
DC rated current	20.4 A at 110 V
Efficiency	>88%
DC input current ripple	< 50% of DC rated current
Monitoring systems	
DC undervoltage, switch-off	Fault < 85% of 110 V (93.5 V), without delay Acknowledgement > 103% of 110 V (113.3 V), 15 s delay
DC overvoltage, switch-off	Fault > 128% of 110 V (140.8 V), without delay Acknowledgement < 125% of 110 V (137 V), 15 s delay
AC undervoltage, switch-off	Fault < 90% rated (207 V), 2.5 s delay Acknowledgement by ON/OFF switch
Overtemperature, switch-off	Fault > 80 °C, acknowledgement < 70 °C, approx. 5 s delay

Type E-number	E230 E230/115/2-VFp26,5-8 3000000646
Rated output capacity	26.5 kVA
Power loss	< 200 W
AC rated input voltage	230 V
AC rated input frequency	50 Hz
Monitoring systems	
AC mains undervoltage, blocking of the SBS	Fault < 90% nominal (207 V), without delay Acknowledgement > 90% nominal (211 V)
AC mains overvoltage, blocking of the SBS	Fault > 110% nominal (253 V), without delay Acknowledgement < 110% nominal (248 V)
AC load undervoltage, switchover to mains	Fault < 88% nominal (202 V), without delay Acknowledgement > 88% nominal (207 V)
AC load overvoltage, switchover to mains	Fault > 112% nominal (258 V), without delay Acknowledgement < 112% nominal (253 V)
Overtemperature, message	Fault > 80°C, acknowledgement < 70°C, 4 s delay self-acknowledging
Synchronism INV / SBS circuit	Fault phase deviation > 3° el., without delay Acknowledgement phase deviation < 2.9° el., 2 s delay

9 Dimensional Drawing

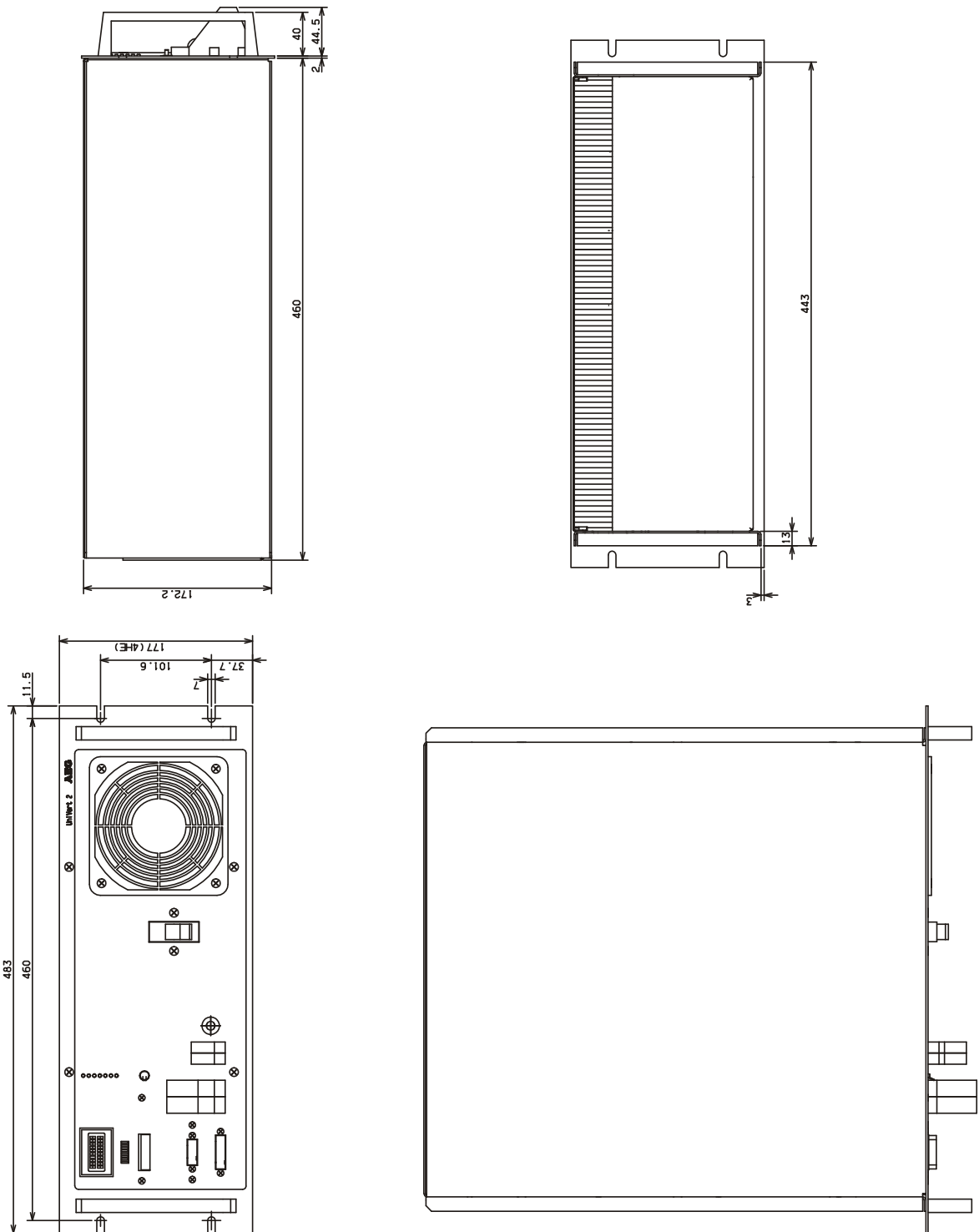


Figure 6 Inverter dimensions (type 1.5 and 3.3 kVA)

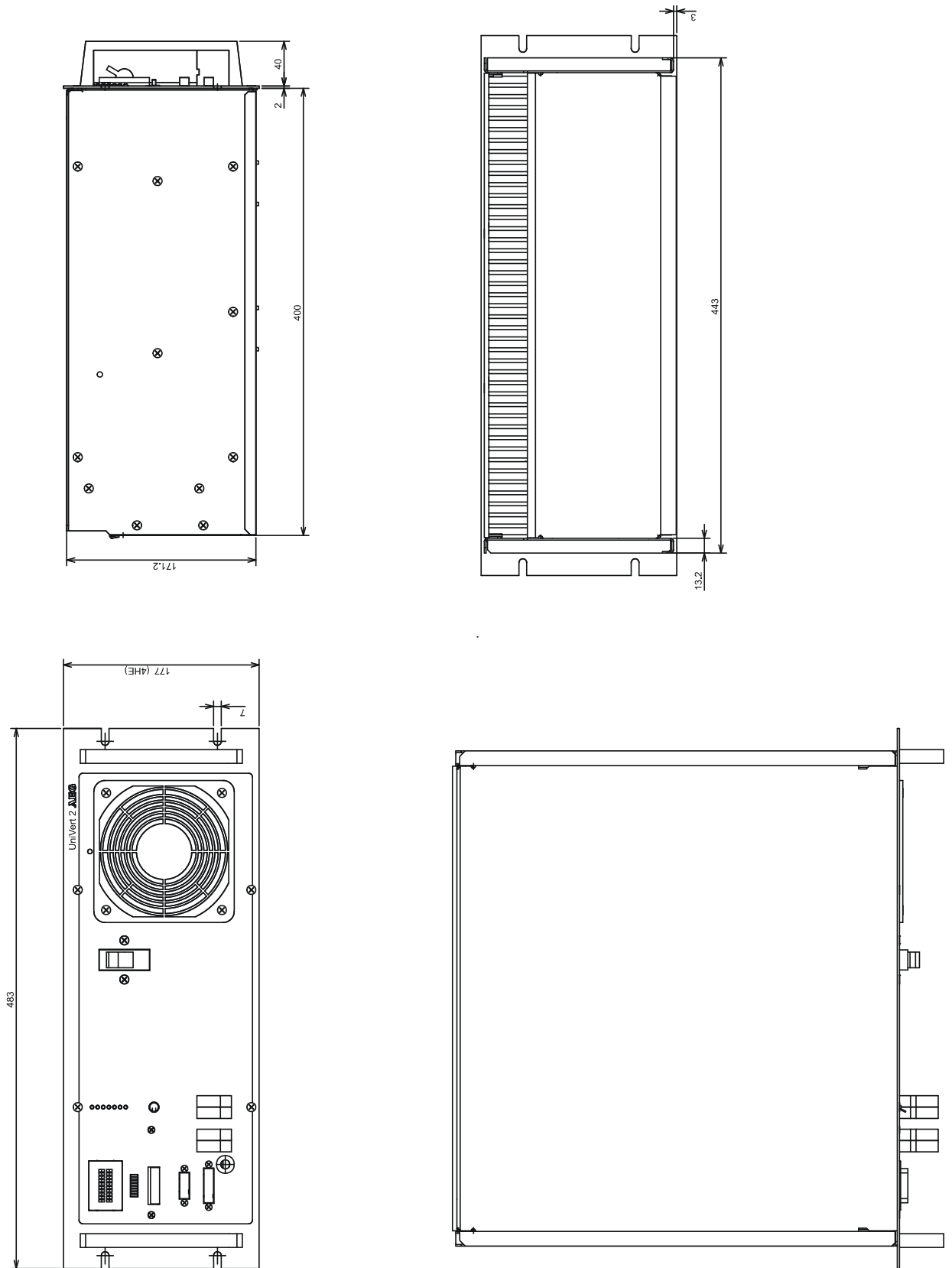


Figure 7 Inverter dimensions (type 2.5 kVA)

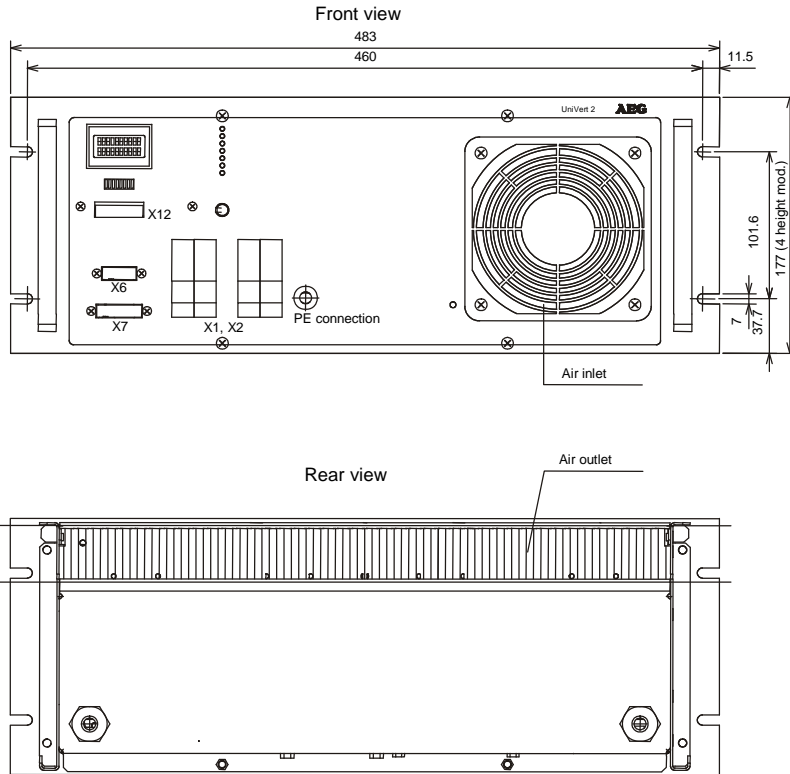


Figure 8 SBS dimensions